FEATURE:
ENDANGERED SPECIES

An historic photo of bull trout anglers in the Flathead River, Montana (circa 1950).

Surveying Professional Opinion to Inform Bull Trout Recovery and Management Decisions

ABSTRACT: Increasing concerns about management and recovery of the threatened bull trout (*Salvelinus confluentus*) prompted the Bull Trout Committee of Western Division American Fisheries Society to survey scientists working most closely with bull trout in Pacific Northwest drainages of the contiguous United States. We solicited scientific and judgment-based assessments regarding current status and future trends, limiting factors, effectiveness of restoration strategies and regulatory mechanisms, and information gaps. The survey was sent to 235 biologists, with the majority of the responses coming from Montana, Oregon, and Washington. Respondents indicated fish passage, forest management practices, and nonnative species interactions are the primary factors limiting bull trout populations, and these issues were identified as the primary recovery challenges in the foreseeable future. Survey results indicated large information gaps in our understanding of bull trout population dynamics, monitoring and evaluation, and community interactions. Finally, survey respondents across demographic groups identified the listing under the Endangered Species Act as the single most important regulatory action benefiting bull trout. We conclude online surveys of professional opinions can be useful for guiding future management decisions, identifying research needs, understanding the relative importance of potential limiting factors, and evaluating the effectiveness of different regulatory mechanisms.

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Sondeo de opinión profesional para informar los resultados de la recuperación y manejo de la trucha toro.

RESUMEN: La preocupación creciente sobre el manejo y recuperación de la trucha toro (*Salvelinus confluentus*) alertó al Comité de la Trucha Toro de la División Oeste de la Sociedad Americana de Pesquerías para que realizara un sondeo de opinión entre científicos dedicados al estudio de la trucha toro en las desembocaduras localizadas en Pacífico noroeste de los Estados Unidos de América. A este respecto, solicitamos evaluaciones científicas y de opinión acerca del estado actual, tendencias futuras, factores limitantes, efectividad de las estrategias de recuperación, mecanismos de regulación y huecos de información. El sondeo se envió a 235 biólogos y la mayoría de las respuestas provino de Montana, Oregon y Washington. Las respuestas indicaron que los pasajes por donde transitan estos peces, las prácticas de manejo forestal y la interacción con especies foráneas son los principales factores limitantes para las poblaciones de trucha toro, y estos aspectos fueron identificados como los principales retos para la recuperación de la trucha toro, al menos en el futuro cercano. El sondeo también reveló importantes huecos de información en cuanto a nuestro entendimiento de la dinámica poblacional, monitoreo, evaluación e interacciones comunitarias de la trucha toro. Finalmente, aquellos que respondieron al sondeo reconocieron la inclusión de la trucha toro en el Acto de Especies Amenazadas como la más importante acción de regulación en beneficio de la especie. Concluimos que el sondeo en línea de opinión profesional puede ser una guía útil para las decisiones de manejo que se tomen en el futuro, para identificar necesidades de investigación, entender la importancia relativa de los potenciales factores limitantes y evaluar la efectividad de distintos mecanismos de regulación.

INTRODUCTION

Bull trout (*Salvelinus confluentus*) is a native char found in rivers and lakes of the Pacific Northwest, ranging historically from northern California to northern British Columbia and Alberta. The bull trout is a top-level piscivore that is unique among western native trout because of its potentially large size (to 15 kg), high longevity (commonly 13 years or more), and adaptable life history patterns (fluvial, adfluvial, anadromous, and resident forms). Bull trout that reside within freshwater habitat tend to be more migratory than most other non-anadromous salmonids, with spawning, foraging, migrating, and overwintering movements up to 250 km in large interconnected systems (Fraley and Shepard 1989).

In the late 1980s, fisheries scientists recognized the unique attributes of bull trout and expressed concern that this was a species at risk (Howell and Buchanan 1992). The increased scientific focus led to expanded research throughout its range (e.g., Mackay et al. 1997; Rieman et al.

1997; Brewin et al. 2001). In 1993, WDAFS created a formal Bull Trout Committee to aid in conservation issues, provide peer review, support research, and inform committee members of issues related to both the science and management of bull trout.

An age 2 bull trout from the Swan River Drainage, Montana (photographed in solarium).

Because of widespread reductions in abundance, distribution, and genetic diversity from historical levels, the bull trout was listed under the U.S. Endangered Species Act (ESA) as a threatened species in U.S. portions of the Columbia River basin in 1998 (USFWS 1998), a listing which was expanded throughout the coterminous 48 states in 1999 (USFWS 1999). Declines are largely attributed to habitat degradation and fragmentation, interactions with nonnative salmonids, and overexploitation (Rieman et al. 1997). Draft Bull Trout Recovery Plans were published in 2002 and expanded in 2004 (USFWS 2002 and 2004), and critical habitat was formally designated in 2005 (USFWS 2005). In 2004, the U.S. Fish and Wildlife Service (USFWS) initiated a formal five-year status review, which is yet to be completed.

In the spring of 2005, following a request by its Species of Special Concern Committee, the Montana Chapter of AFS (MTAFS) formally requested the WDAFS Bull Trout Committee survey bull trout biologists to assess the effectiveness and progress of bull trout restoration and recovery efforts. The MTAFS request to WDAFS specifically noted that: "Uncertainty about the effectiveness and implementation of regulatory mechanisms, including state and tribal recovery plans and the Endangered Species Act processes, somewhat clouds future prospects for bull trout recovery. Given those elements of uncertainty and concern that policy decisions regarding future protection for bull trout and their habitat may not adequately consider the science necessary to fully support bull trout recovery….." Following discussion, the WDAFS Executive Committee endorsed and initiated the survey in November 2005.

METHODS

To meet the objectives set out by the MTAFS and WDAFS to develop a robust and objective survey, a Bull Trout Survey Subcommittee which included the authors was formed. The subcommittee included biologists from state and federal governments, hydropower utilities, non-governmental organizations, and academia (see Acknowledgments). We used terminology provided in the Draft Bull Trout Recovery Plan (USFWS 2002, 2004) for designing the survey, because of its general use and acceptance for describing bull trout populations. The plan is organized around a hierarchical approach to population units and describes 121 bull trout core areas across the range in the 5 western states where bull trout occur. Core areas described in the plan constituted the basic units upon which bull trout recovery is to be gauged (USFWS 2002, 2004). To standardize the survey approach throughout the range and to avoid potential ambiguity associated with various population terms (local populations, metapopulations, subpopulations, etc.), we designed questions that addressed bull trout population units at the core area level as described in the plan. Because some respondents would likely be familiar with multiple core areas, respondents were allowed to complete a maximum of five separate surveys for questions related to different core area populations.

SURVEY DETAILS

The survey developed by the subcommittee contained six components: respondent background, status and trend of bull trout populations and habitat, limiting factors, effectiveness of restoration strategies, effectiveness of various regulatory mechanisms, and information gaps. In total, we asked19 questions (see Appendix), several of which had 2 parts.

The background information component included questions regarding the professional and geographic experience, expertise, and educational background of the biologist. The purpose of the background questions was to assess qualifications of respondents as a group (not individually) and to potentially account for variability in the responses to the survey.

The second component of the survey included two questions related to the status and trends of bull trout populations. The first question asked if the bull trout population in the individual core area considered by the respondent had increased, decreased, remained stable, or if the trend was unknown over the most recent decade. The second question asked whether the quantity of habitat in the core area had increased, decreased, remained the same, or if the trend was unknown over the most recent decade. There was no attempt to assess habitat quality, as the subcommittee viewed that as too subjective to be adequately quantified in this survey.

For these and some subsequent questions, respondents were asked to qualify their answers according to the level of information they used to generate each response. Four categorizes were used to assess the level of information quality on which responses were based, from most rigorous to least: (1) peer-reviewed empirical trend data, (2) short term or incomplete empirical data (e.g., redd counts every other year), (3) scientific observation not backed by empirical data (e.g., some evidence, but not statistically rigorous), and (4) anecdotal information.

The third component of the survey focused on the variability of factors limiting a particular bull trout core area population. Respondents were asked to rank the five most important categories of management activities they felt could induce limiting factors, and to rank those limiting factors relative to their contribution to the current status of bull trout (Table 1). There were two separate components for each question: one related to historical management activities (most recent decade) and the other to future activities (next 10 years). Ten years was used as a temporal frame of reference, as it approximates two bull trout generations and the subcommittee viewed it as representative of the context in which many biologists would consider past and future assessments related to this fish.

Table 1. A list of potential factors limiting bull trout populations.

- Agricultural practices
- Angling or harvest (legal and illegal)
- Dewatering
- Entrainment (hydropower and diversions)
- Fish passage issues (barriers to migration)
- Forest management practices and forest roads
- Introduced species (fish or other organisms)
- Livestock Grazing
- Mining (including oil and gas)
- Residential development and urbanization
- Transportation networks (e.g., major highways, railroads, etc.)
- Water quality impairment from non-specific or multiple sources
- Currently no apparent limiting factors
- Other (specify)

The fourth component of the survey used questions to assess the effectiveness of various strategies at facilitating bull trout restoration or protecting existing status in each core area. Respondents were asked to rank the 5 most important categories of restoration strategies for their relative potential to contribute to the healthy status of bull trout populations over the next 10 years (Table 2).

Table 2. A list of potential restoration strategies for bull trout core areas.

- Agricultural practice improvements
- Angling regulation and angler education
- Fish passage improvement/removal of barriers
- Forest management practice improvements
- Grazing practice improvements
- Long term habitat protection (e.g., wilderness, National Park)
- Habitat restoration (watershed based or site-specific)
- Improved water quality (e.g., TMDL's)
- Improved water quantity (e.g., instream flow requirements)
- Nonnative species control
- Reduced forms of mortality (e.g., incidental or illegal harvest)
- Other

The fifth component assessed professional opinions regarding which regulatory mechanisms have been historically most effective and are likely to continue to be effective in the next 10 years in furthering the restoration and/or protection of the bull trout population in a given core area. There were 2 separate questions in this component: respondents were asked to rank the top 5 regulatory mechanisms (Table 3) based on their past and current effectiveness in contributing to bull trout population status and to assess the same regulatory mechanisms for their likely effectiveness in the next 10 years.sixth component focused on the state of our knowledge regarding bull trout biology and management strategies. Respondents were asked to identify up to 5 categories where the largest information gaps occur and, if given the opportunity, where respondents would allocate the most resources over the next 10 years. Bull trout research categories included (in alphabetical order): angling and fishery management, biology and physiology, genetics, habitat relationships, migratory patterns, movement and tracking, population dynamics (e.g., demographics, vital rates), population monitoring and evaluation (basic abundance and distribution), species and community interactions (e.g., nonnative species), and other.

Table 3. A list of regulatory actions potentially affecting bull trout.

- Clean Water Act (TMDLs and 303d lists)
- ESA Threatened listing (1998...)
- ESA Section 7 Consultations (1998...)
- ESA Draft Recovery Plan (2002 and 2004)
- ESA Critical Habitat proposed and final rule (2005)
- FERC licenses or agreements
- Forest plans
- HCP's, Safe Harbor Agreements, and other voluntary strategies
- PacFish, InFish, or similar "watershed" protection strategies
- State or tribal bull trout management plan(s)
- Other (specify)

This survey was intended to include as many bull trout biologists as possible, and to collect as much information across broad landscape and demographic lines as was feasible, thus allowing for a comprehensive assessment of the variability of biologists' opinions. To prevent potential bias associated with biologists' employment affiliation, we made considerable effort in the design of questions and survey protocol to ensure anonymity of respondents. For example, in order to allow evaluation of the variability in responses by geographic region, respondents were asked to identify the location by state (Oregon, Washington, Montana, Idaho, or Nevada) of the particular core area they were addressing in the survey, but names of specific core areas were not requested.

We developed state-by-state lists of prospective respondents through information obtained by members of the bull trout subcommittee, augmented by additional resources at our disposal (e.g., professional meetings). Prior to being released, the survey was reviewed by a select group of biologists who were familiar with fisheries terminology and in some cases bull trout issues, but were outside our survey pool (e.g., Canadian collaborators), and by an external reviewer with expertise in designing survey questionnaires.

In April 2006, we distributed a cover letter describing the background of the survey and instructions for access to the survey (via a commercial website, SurveyMonkey.com) through e-mail from WDAFS to 235 bull trout biologists in U.S. portions of the Pacific Northwest. We encouraged biologists to forward the survey to coworkers who may have been missed, including those who had past experience with bull trout and had maintained an active interest in bull trout research, monitoring, or management. The subcommittee asked participants to complete the survey within two weeks and provided instructions on how to decline the survey to those who considered themselves as unqualified or where participation was otherwise problematic. We encountered difficulties in reaching some potential respondents due to Internet spam blockers; however, we forwarded the contact letter through multiple channels to maximize the number of qualified scientists surveyed. We extended the survey period for participants who received late notification, and closed the survey after about one month of gathering responses. Additionally, a final opportunity for participation in the survey was provided at a professional meeting (i.e., WDAFS Annual Meeting), although very few responses were received at that late juncture.

DATA ANALYSIS

We performed summary statistics for each question in the survey. With questions involving a rank of answers (e.g., 1 through 5), we calculated a weighted estimate and reported the relative importance for each category based on the following equation:

$$R_i = [(5*\Sigma n_1) + (4*\Sigma n_2) + (3*\Sigma n_3) + (2*\Sigma n_4) + (1*\Sigma n5)] / (R_{max})$$

where R is the relative importance, i is the category for a particular question, n is the number of responses for each ranking (1 through 5), and Rmax is the category with the highest response value; thus, categories with the highest ranking (1) were given the most weight (5).

We summarized the survey data at two levels. First, we partitioned the data at the state level to allow analyses of similarities and differences across geographic regions. Because Nevada represents such a small portion of the bull trout range (single Jarbidge River core area), we grouped this core area with adjacent Idaho. Next, because bull trout are listed under the ESA at the species level, we calculated similar metrics for all responses with no partitioning by state (United States only; hereafter referred to as range-wide), which provided a comprehensive summary of biologist opinions.

RESULTS

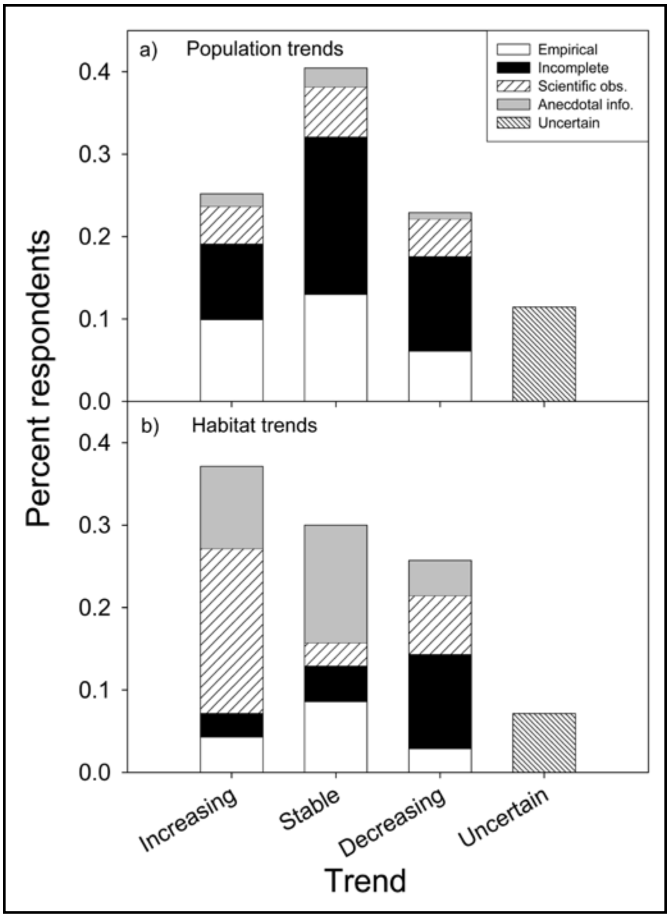
We received completed surveys from 87 respondents, which represented a 37% response rate to the original distribution list for the survey. Some respondents chose to answer only certain questions; hence, sample sizes were not the same for every question. Montana, Oregon, and Washington had the most respondents with 33, 24, and 21 survey participants, respectively; Idaho/Nevada had the fewest respondents with 8, and 1 respondent did not report a location. The majority of the respondents were affiliated with federal agencies, state agencies, and academic institutions (41%, 22%, and 11%, respectively). AFS membership was not required to take the survey, although 77% of respondents indicated they were AFS members. Because some respondents provided input for more than one core area, we received a total of 103 core area characterizations. Of the core areas that were characterized, the highest number were in Montana (n = 33), followed by Oregon (n = 27), Washington (n = 23), and Idaho/Nevada (n = 9); and 12 responses failed to include this information. This article presents and discusses primarily the range-wide results, with regional interpretation where it is particularly valuable or informative. More detailed results are provided in the Appendix (Tables A1 through A5).

Results for the second component of the survey, population trends, indicated that range-wide the highest number of responses were based on short-term or incomplete data (39%), 31% percent of responses were either uncertain or based on nonempirical scientific observations or anecdotal information, and only 28% of the core area population trend determinations were based on the most rigorous category of peer-reviewed empirical data (Figure 1a). Overall, there was no apparent pattern suggesting a particular range-wide trend in population abundance (e.g., increasing vs. decreasing) at the core area level.

When survey results for population trends were analyzed by geographic location of the core area, there was variability among states in both the source of information used to generate responses and in the direction of core area population trends (Table A1). Opinions regarding the current trend of core area populations in Idaho (albeit small sample size) and Montana had a higher proportion of responses based on peer-reviewed, empirical data (47% and 38%, respectively; Table A1). Oregon (18%) and Washington (19%) had substantially fewer responses based on rigorous information (peer-reviewed empirical trend data and short term or incomplete empirical data). When the level of information on which the survey responses were based was disregarded, there was significant variability in the range of responses by state in identifying increasing population trends (from 16 to 30%), stable trends (from 31 to 60%), and decreasing trends (from 13 to 36%), but no particular direction to the overall trend in each state was apparent.

Range-wide responses (United States only) indicated even fewer empirical data exist for assessing trends in habitat quality at the core level than observed for population trends (Figure 1b). Responses to habitat trend for 16% of core areas were based on the most rigorous peer-reviewed empirical data and for 19% short-term or incomplete empirical data were used. Nearly two-thirds (66%) of the habitat trend determinations were either uncertain, or were based on non-rigorous scientific observations

Figure 1. Results indicating the trends (increasing, stable, decreasing, and uncertain) and quality of information used to evaluate trends of bull trout abundance (a) and quantity of bull trout habitat (b) at the core area level. Quality of information included peer-reviewed empirical trend data (empirical), short term or incomplete empirical data (incomplete), scientific observation not backed by empirical data (scientific obs.), and anecdotal information (anecdotal info.)

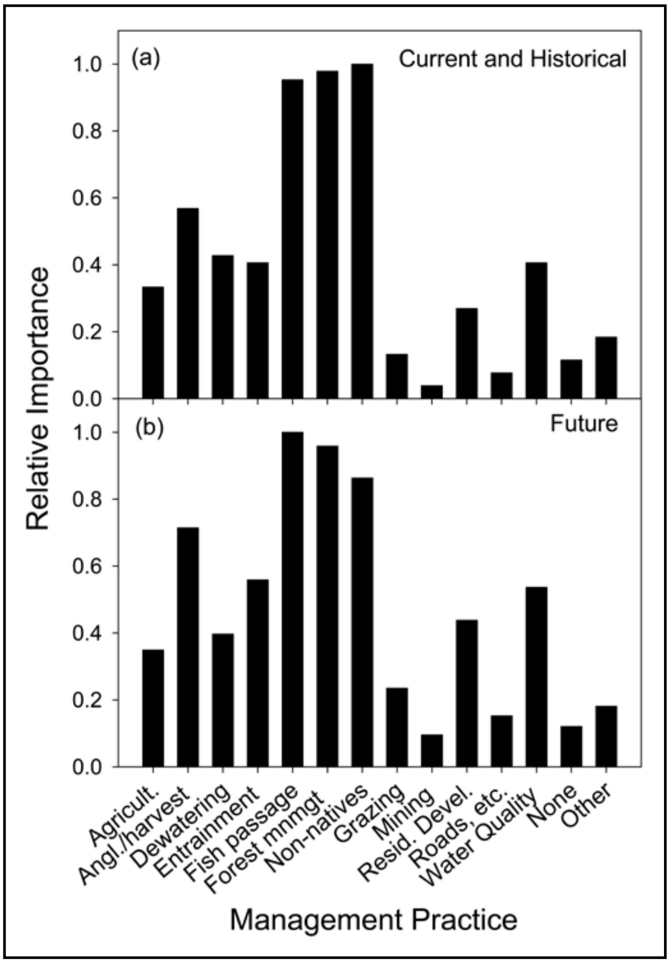


or anecdotal information. When the level of information used to inform the survey responses was disregarded (i.e., no delineation of empirical and less-rigorous responses), there was no apparent pattern regarding the range-wide trend of habitat quantity; 37% of the responses suggested increasing trends, 30% stable trends, and 26% decreasing trends.

In analyzing responses based on geographic location of the respondent, the pattern regarding information used to describe habitat trends was similar to the range-wide results (Table A1). Few responses were based on empirically-based, peer-reviewed data (from 0 to 16%) and short-term or incomplete empirical data (from 26–39%), while 50–77% of the responses were based on non-empirical scientific observations, anecdotal information, or "uncertain". When information used to generate responses was not included, the majority of the responses suggested that habitat conditions were stable across states (from 47–67%), while there was little difference between the percent of responses indicating increasing (from 7–34%) and decreasing trends (from 13–22%).

Nonnative species, forest management strategies, and fish passage issues were considered the top factors limiting bull trout populations at the range-wide level. The results were similar for factors affecting historical and current population status (Figure 2a) as well as when considering future limiting factors (Figure 2b). In the geographic analysis of responses, there was substantial variability across states as to the relative rank of each management activity; however, similar to the range-wide responses, nonnatives, forest management activities, and fish passage issues were generally the highest ranking factors (Table A2).

Figure 2. Relative importance of different management strategies that can induce limiting factors for the current and historical (a) and future (b) status of bull trout populations at the core area level (see Table 1 for complete description of management strategies).



Range-wide rankings (United States only) of the importance of various restoration activities generally paralleled those limiting bull trout populations. Nonnative species control, fish passage improvements, and habitat restoration received the highest rankings for their relative potential to contribute to the healthy status of bull trout populations over the next 10 years (Figure 3). When responses were analyzed by state, fish passage improvements and habitat restoration were consistently ranked highly (Table A3); however, there was substantial variability among states relative to the importance of different restoration strategies.

The ESA listing of bull trout as threatened was identified by most respondents, both at the state level and range-wide, as being the most effective regulatory mechanism for the current and future protection and recovery of bull trout (Figure 4; Table A4). ESA Section 7 consultations received the next highest rankings range-wide and relatively high rankings across states.

Finally, range-wide responses identifying research fields where the greatest information gaps for bull trout occur were uniformly highest for population dynamics (including demographics, vital rates, and modeling), population monitoring and evaluation, and species and community interactions (e.g., nonnative species; Figure 5). Analysis of responses by geographic area (Table A5), indicate considerable variability in ranking among states.

DISCUSSION

We found a professional opinion survey can be a useful, cost-effective and informative tool to assess areas where scientifically-based differences of opinion occur. This was demonstrated in our survey of diverse scientists working to restore bull trout populations in the U.S. portions of the Pacific Northwest. This survey was

Figure 3. The relative importance of different restoration activities for their potential to contribute to the healthy status of bull trout populations over the next 10 years (i.e., short term; see Table 2 for full description of restoration activities).

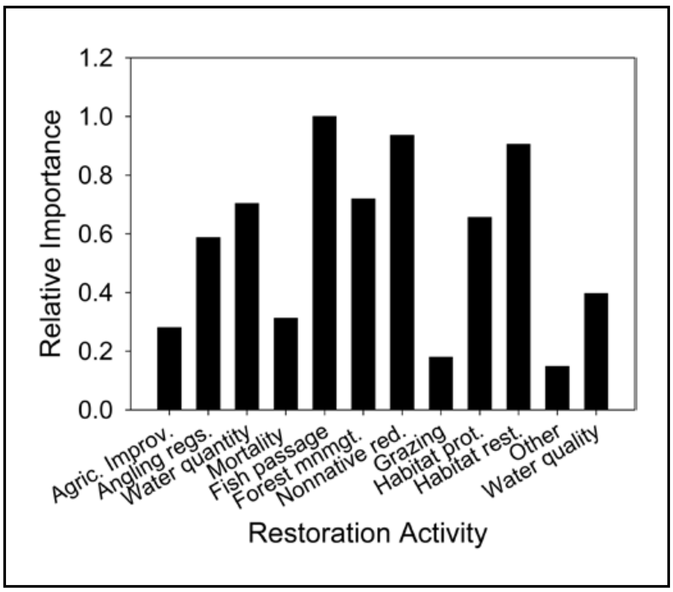


Figure 4. Rangewide responses of the relative importance of different regulatory mechanisms or guidance documents that may have assisted in current (a) and future (b) protection and restoration of bull trout populations.

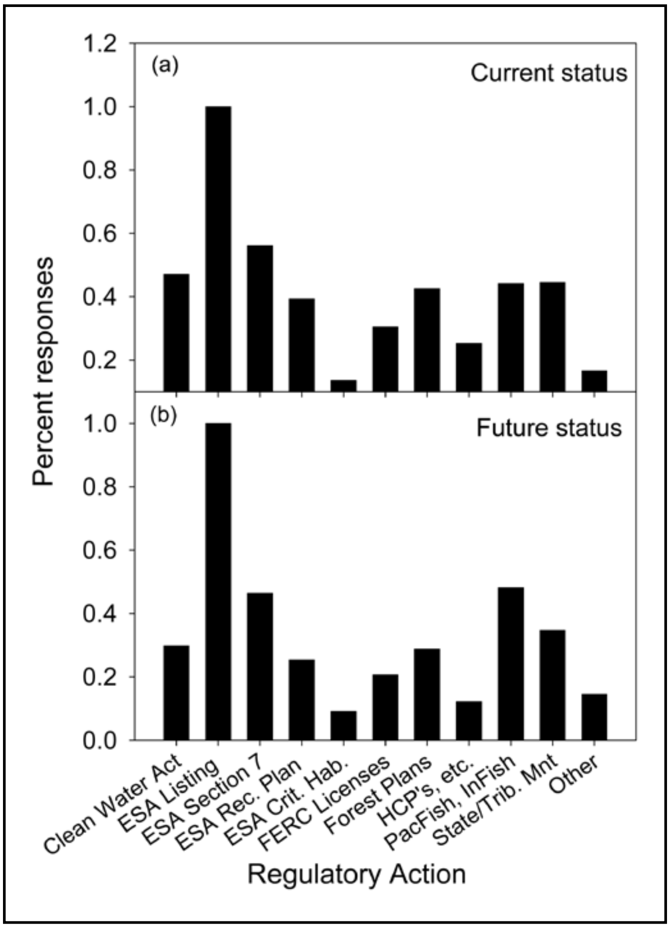
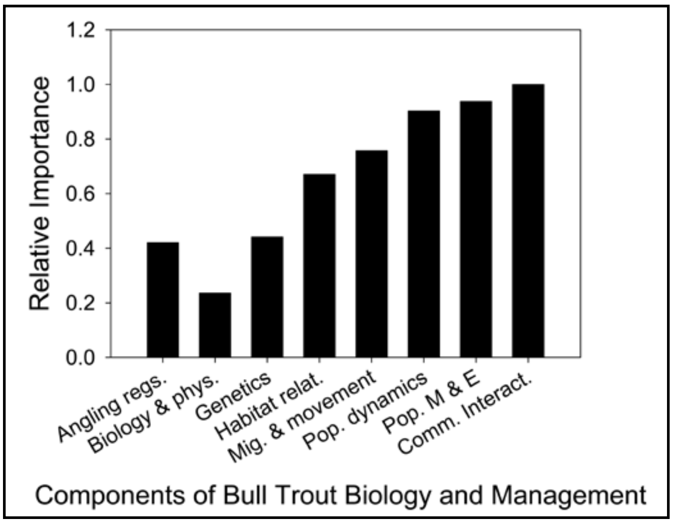


Figure 5. Rangewide responses of the relative rank of pre-selected categories where information gaps are known to occur regarding bull trout biology, population structure, and management, and where biologists would choose to allocate resources over the next 10 years. Categories are: (a) angling and fishery management; (b) biology and physiology; (c) genetics; (d) habitat relationships; (e) migratory patterns, movement and tracking; (f) population dynamics; (g) population monitoring and evaluation; and (h) species and community interactions.



Low flow conditions at Thompson Falls Dam on the Clark Fork River, Montana, where no fish passage facilities are currently available.

conducted by a volunteer effort of WDAFS members, with minimal financial outlay.

The survey results, as with any poll, should be considered to represent the opinions of those included as respondents, as well as the information available to those individuals. Furthermore, the nonrandom design and geographically uneven response rate means that it is statistically nonrepresentative of all who would consider themselves bull trout biologists. However, the value of the results was increased by the design of the questions and the considerable planning and foresight incorporated to ensure that quality input was received. We consider the respondent sample size (n = 87) and relative consistency of responses to have provided a useful and rapid assessment of opinions of professional bull trout biologists in the U.S. portion of the species range.

Sullivan et al. (2006) note there are positive and negative attributes of various sources of scientific information. Expert opinion, the method used for our bull trout biologist survey, is categorized as "highly reliable, especially when it is based on the experience of multiple experts who collectively function as peer reviewers of a sort." Expert opinion is further characterized as: "... the only form of scientific knowledge available for some crucial policy issues." Sullivan et al. (2006) also indicated that expert opinion has an advantage over published literature based on field research, in being timely and providing "immediate" feedback, an attribute that was effectively demonstrated by the implementation of this survey.

However, such opinion surveys have shortcomings as well. Yoder and Rankin (1995) reported that qualitative assessments of fish assemblage condition tended to be more optimistic than quantitative assessments. Paulsen et al. (1998) found that nonrandom surveys tended to overestimate water body and coho salmon (*Oncorhynchus kisutch*) status because of nonrandom site selection being biased toward less disturbed sites. An alternative, albeit far more expensive and time consuming approach is to conduct rigorous field surveys through use of a probabilistic survey design (e.g., Paulsen et al. 1998; Dambacher and Jones 2007; Whittier et al., in press).

Nonetheless, as the electronic age advances, rapid feedback is becoming a more important part of our culture, from news to weather to the arts and science. As fisheries scientists, we should actively embrace opportunities to use new and different methods not previously available, such as the online survey employed here. A survey of this type allows an occasional "check on the pulse" of the scientific community and a determination of whether expert practitioners closest to the subject believe the intersection of science and policy translates into meaningful protection and restoration of species. The inclusive and controlled method by which this survey evolved and was administered through WDAFS protocol and guidance, combined with the high level of professionalism embodied by the respondents, separates a professional opinion survey of this nature from random public opinion polls.

Specific to bull trout, we have gleaned important messages about restoration efforts from this survey of professional opinions. First, and not surprisingly, the results (Figure 1) suggest that real population or habitat trends from the cross-section of bull trout core areas we surveyed are not yet evident. These findings may conflict with public perception, often on a localized scale, that bull trout populations are either fully recovered and not in need of protection, or conversely, are spiraling rapidly downward toward extinction. Bull trout are relatively long-lived and widely-distributed salmonids which naturally occur at low densities, often disproportionately distributed in inaccessible backcountry areas and headwater habitats (Al-Chokhachy 2006). The biological attributes of the species (fall spawning and reliance on cold, clean water) may make bull trout particularly susceptible to natural or human-caused habitat and climatic changes (e.g., Rieman et al. 2007). Thus, a decade may be an insufficient amount of time to detect trends, even with good scientific data (Staples et al. 2005; Al-Chokhachy 2006). Furthermore, the survey results indicate fishery scientists do not currently place high confidence in the adequacy of existing empirical data upon which to base core area population and habitat trend assessments (see data quality ratings in Figure 1). These results are consistent with responses from another portion of the survey (see Figure 5) indicating population and habitat monitoring and evaluation are high priorities for further research emphasis.

A second important finding of this survey was the consistency in the opinions of biologists that fish passage, forest management practices and roads, and nonnative species interactions as the primary historical, current, and likely future limiting factors for bull trout (Figure 2). Along with habitat restoration, these three areas were also rated as the most important target areas for future restoration efforts (Figure 3). While many existing mitigation and protection activities emphasize these factors, the migratory nature of bull trout makes it even more critical that restoration activities be coordinated at the larger basinwide scale (typically synonymous with core area) to be most effective.

Finally, there is clear and overwhelming agreement from respondents to this survey, regardless of their background, jurisdiction, or affiliation, that the single most important regulatory action benefiting bull trout is its ESA listing status as a threatened species (Figure 4). Second most important are Section 7 consultations, the regulatory review of Federal projects carried out under the ESA. Respondents assigned lower, but substantially important benefits to the Clean Water Act, Draft Bull Trout Recovery Plan, forest plans, PacFish/Infish standards, and state and tribal management plans.

Results from this survey are consistent with many of the themes of a similar professional survey conducted in Alberta (Brewin 2004). That survey also found there was insufficient monitoring data to comprehensively evaluate population trends and concluded that long-

Stream electrofishing in Swan River drainage, Montana to assess brook trout and bull trout hybridization (2007).

term commitment of resources, as well as increased collaboration and cooperation amongst resource managers and interested cooperators, was needed to increase success of recovery efforts (Brewin 2004).

FUTURE CONSIDERATIONS

Obtaining information related to the status, trend, and gaps in current research can be extremely difficult for species such as bull trout that occupy broad spatial patterns. While surveys may not provide empirical assessments of factors such as population status and trend, they can be extremely helpful in collectively assessing information from the scientific community, bridging communication gaps existing across different entities, and helping guide research and management. The results of this survey indicated consistency in the perceived factors limiting bull trout, the effectiveness of different regulatory actions, and data limitations and research needs. However, despite these consistencies, there is some uncertainty as how specific components of management and regulatory actions have detrimental/positive effects on bull trout populations. For example, forest management practices were noted as a historic, current, and future factor limiting bull trout. The concept of "forest management" includes a wide variety of actions not delineated in this survey; thus, future research may be necessary to help identify the effect of different management and recovery actions on bull trout status and trends. As such, we urge consideration of these results as we move forward in understanding the ecology and designing effective management strategies for this species.

Despite the relative success of this survey, there were limitations in our survey that can be improved in future efforts. First, we experienced difficulties in distributing this survey to intended reviewers as a result of e-mail filters within different state/federal agency offices. We were able to include additional venues to reach out to respondents through professional meetings, but future surveys should consider as many resources as possible and potential setbacks to reach the intended respondents. Next, although not conducted here, future surveys of professional opinion might consider a means to ground-truth or validate responses, where synthesized opinions are compared against empirical data. Here, we were not able to conduct this type of validation effort due to our lack of resolution in our responses to relevant population units (i.e., core areas), which resulted from our efforts to keep respondent's opinions anonymous. For future surveys, this validation may be particularly important where questions and responses relevant to the survey differ substantially across relevant spatial scales. In lieu of these limitations, this survey can be used by AFS, both at the Western Division and local Chapter levels, as a blueprint to guide future involvement in meaningful policy dialogue about bull trout restoration issues. Further, we consider our approach a useful tool to aid governmental, tribal, and non-governmental entities in evaluating complex resource concerns across broad spatial and political scales. ♋

Complex stream habitat in Glacier National Park.

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Appendix 1.

Table A1. State by state comparisons of results indicating the trend of bull trout abundance and quantity of habitat at the core area level, and the quality of information used to evaluate trends.

	Core area population trend				Habitat trend			
Trend	**WA**	**OR**	**MT**	**ID**	**WA**	**OR**	**MT**	**ID**
Increasing: peer-reviewed empirical trend data	0.06	0.13	0.07	0.13	0.00	0.05	0.02	0.00
Increasing: short term or incomplete empirical data	0.13	0.08	0.09	0.00	0.10	0.05	0.02	0.07
Increasing: scientific observation not backed by empirical data	0.03	0.08	0.00	0.07	0.13	0.13	0.11	0.00
Increasing: anecdotal information	0.03	0.03	0.00	0.00	0.00	0.11	0.07	0.00
Stable: peer-reviewed empirical trend data	0.09	0.05	0.20	0.27	0.00	0.03	0.11	0.00
Stable: short term or incomplete empirical data	0.16	0.28	0.18	0.13	0.19	0.16	0.27	0.20
Stable: scientific observation not backed by empirical data	0.06	0.08	0.02	0.13	0.19	0.21	0.20	0.33
Stable: anecdotal information	0.00	0.03	0.02	0.07	0.13	0.08	0.02	0.13
Decreasing: peer-reviewed empirical trend data	0.03	0.00	0.11	0.07	0.00	0.00	0.02	0.00
Decreasing: short term or incomplete empirical data	0.13	0.13	0.16	0.07	0.10	0.05	0.09	0.07
Decreasing: scientific observation not backed by empirical data.	0.06	0.00	0.09	0.00	0.10	0.08	0.00	0.00
Decreasing: anecdotal information	0.03	0.03	0.00	0.00	0.03	0.00	0.02	0.13
Uncertain	0.19	0.13	0.07	0.07	0.03	0.05	0.02	0.07
Other (specify)								

Table A2. State by state comparisons of the relative importance of different management activities that can induce limiting factors in the current and historical and future status of bull trout populations

Management activity	Current and historical status WA	OR	MT	ID	Future status WA	OR	MT	ID
Agricultural practices	0.29	0.49	0.10	0.15	0.37	0.55	0.09	0.14
Angling or harvest (legal and illegal)	0.59	0.32	0.41	0.72	0.56	0.52	0.63	0.43
Dewatering	0.25	0.38	0.38	0.13	0.29	0.33	0.40	0.11
Entrainment (hydropower and diversions)	0.41	0.36	0.31	0.51	0.32	0.41	0.29	0.45
Fish passage issues (barriers to migration)	0.75	1.00	0.66	0.67	0.66	1.00	0.60	0.39
Forest management practices and forest roads	1.00	0.63	0.65	1.00	1.00	0.67	0.77	1.00
Introduced species (fish or other organisms)	0.37	0.50	1.00	1.00	0.68	0.69	1.00	0.95
Livestock grazing	0.06	0.21	0.14	0.15	0.08	0.22	0.23	0.09
Mining (including oil and gas)	0.00	0.01	0.06	0.10	0.00	0.02	0.17	0.09
Residential development and urbanization	0.35	0.27	0.28	0.21	0.63	0.39	0.54	0.27
Transportation networks (i.e. major highways railroads etc.)	0.06	0.10	0.06	0.13	0.08	0.17	0.20	0.20
Water quality impairment from nonspecific or multiple sources	0.43	0.46	0.30	0.44	0.56	0.59	0.51	0.36
Currently no apparent limiting factors	0.15	0.04	0.10	0.00	0.17	0.00	0.03	0.00

Table A3. State by state comparisons of the relative importance of restoration strategies for their relative potential to contribute to the healthy status of bull trout populations over the next 10 years (i.e., short term).

Restoration activity	WA	OR	MT	ID
Agricultural practice improvements	0.40	0.55	0.08	0.10
Angling regulation and angler education	1.00	0.23	0.62	0.87
Fish passage improvement/removals of barriers	1.00	1.00	0.92	1.00
Forest management practice improvements	0.96	0.39	0.81	0.93
Grazing practice improvements	0.11	0.28	0.27	0.10
Habitat protection—long-term (e.g. legislative or statutory such as wilderness National Park)	0.96	0.17	0.73	0.40
Habitat restoration (watershed based or site-specific)	1.00	0.80	0.85	1.00
Improved water quality (e.g. TMDLs)	0.44	0.34	0.58	0.20
Improved water quantity (e.g. instream flow requirements)	0.56	0.63	0.77	0.40
Nonnative species control	0.58	0.53	1.00	0.93
Reduced forms of mortality (e.g. incidental or illegal harvest)	0.33	0.22	0.65	0.23
Other	0.16	0.25	0.04	0.13

Table A4. Relative importance of different regulatory mechanisms or guidance documents that may have assisted in previous and future protection and restoration of bull trout at the state level.

Regulatory action	Current and historical population status WA	OR	MT	ID	Future population status WA	OR	MT	ID
Clean Water Act (TMDLs and 303d lists)	0.18	0.30	0.68	0.15	0.38	0.48	0.81	0.30
ESA Threatened listing (1998...)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ESA Section 7 Consultations (1998...)	0.50	0.45	0.76	0.31	0.72	0.54	0.78	0.37
ESA Draft Recovery Plan (2002)	0.43	0.30	0.38	0.06	0.56	0.41	0.63	0.30
ESA Critical Habitat proposed and final rule (2005)	0.16	0.08	0.09	0.12	0.25	0.12	0.19	0.09
FERC licenses or agreements	0.30	0.18	0.26	0.15	0.41	0.27	0.37	0.30
Forest plans	0.36	0.30	0.41	0.38	0.44	0.36	0.85	0.15
HCP's Safe Harbor Agreements and other voluntary strategies	0.18	0.05	0.29	0.12	0.22	0.15	0.41	0.50
PacFish InFish or other similar "watershed" protection strategies	0.34	0.32	0.82	0.65	0.22	0.24	0.93	0.41
State or tribal bull trout management plan(s)	0.44	0.23	0.59	0.10	0.47	0.34	0.81	0.11
Other	0.14	0.00	0.29	0.29	0.17	0.00	0.30	0.30

Table A5. State by state comparisons of the relative rankings of information gaps regarding bull trout biology, population structure, and management, and where biologists would allocate resources over the next 10 years.

Component of bull trout biology or management	WA	OR	MT	ID
Angling and fishery management	0.08	0.05	0.11	0.13
Biology and physiology of bull trout	0.05	0.07	0.06	0.03
Genetics	0.12	0.07	0.09	0.08
Habitat relationships for bull trout	0.12	0.12	0.14	0.14
Migratory patterns movement and tracking	0.20	0.14	0.13	0.09
Population dynamics including demographics vital rates modeling	0.13	0.21	0.15	0.15
Population monitoring and evaluation (basic abundance and distribution)	0.19	0.16	0.16	0.20
Species and community interactions (e.g. nonnative species)	0.11	0.18	0.17	0.19